

Summary of Working Group II: Linac-Based, High-Gain FELs

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The Linac-Based, High-Gain FELs working group was a very large group with a variable size (names of registered participants are listed below). The field of Linac-Based, High-Gain FELs is very active with considerable theoretical research and significant proof-of-principle experiments going on in many laboratories. The subject is also complicated by the fact that the source performance is critically dependent on the electron gun and linac performance in sometimes new and unexplored ways.

The presentations given at the working group are listed below:

FEL Theory, Li-Hua Yu, Brookhaven National Laboratory. Li-Hua presented the approach to 3-D high-gain FELs and various expressions that may be conveniently used to estimate the conditions for gain.

Wake Fields, Karl Bane, SLAC. Karl presented the theory of wake-fields, covering the better known wakes due to geometry and resistive wall and also the lesser known rough surface impedance.

Compression, Paul Emma, SLAC. Paul went into great detail of compressor design issues for various configurations and including details of non-linearity, jitter, wake fields and space charge.

Photoinjectors, Bruce Carlsten, LANL. Bruce covered the theory of photoinjectors, the fundamental limitations on emittance, the physics of emittance compensation and schemes for emittance reduction.

Photoinjector simulations, Massimo Ferrario, INFN. Massimo described the fast simulation program HOMDYN, compared its performance to PIC codes and shown simulations for various scenarios.

Radiation Tutorial, Max Zolotarev, LBNL. Max explained various fundamental concepts in E-M radiation physics: formation length, coherence, gain, saturation, intensity / spectral fluctuations.

FEL Numeric Simulations, Heinz-Dieter Nuhn, SLAC. Heinz-Dieter presented various results on FEL calculations including sensitivity of the FEL gain to parameter change, mostly related to the LCLS.

The TTF-FEL, Sven Reiche, DESY. Sven presented the VUV FEL at the TTF including parameters, dependency on electron beam parameters, undulator errors and schemes to improve coherence in SASE.

Harmonics / Code comparison, Henry Freund, SAIC. Henry presented two subjects. One was a detailed comparison of various numeric simulation codes, the other the strength of harmonics in FELs.

CSR Results, Courtlandt Bohn, TJNAF. Court presented the theory of coherent synchrotron radiation emittance growth and initial experimental results on CSR emittance growth from the TJNAF IR FEL.

1 GV/m Pulsed Gun, Triveni Srinivasan-Rao, BNL. Triveni described a new approach to photoinjectors, one based on flat top ultra-high gradient photoelectron sources promising record brightness.

General Considerations, Stephen Milton, ANL. Steve presented general principles that apply to short wavelength FELs concerning the connection between emittance, wiggler parameters and peak current.

Effect of Energy Variations, Heinz-Dieter Nuhn, SLAC. Heinz-Dieter related numerically the energy modulation produced in the wiggler by wake field to the FEL gain, showing some basic limitations.

The discussions that followed both the talk subjects and independently raised items were very productive but beyond the scope of this summary. An example for a subject that came up as a question from another working group, we discussed the aspects of independent wavelength control in multi-user facility. The conclusion was that with a proper design of the linac and beam transport, multiple undulators could be serviced in real time with independent energy control for each undulator.

Major conclusions of the working group were as follows:

1. There is need to continue and improve the emittance and enable the reduction of the peak current from present design values.
2. Bunch compression must deal with CSR. There is no simple way to eliminate it.
3. Rough surface wake field is still an open problem and more research on it is required.
4. There is need for additional experiments, in particular:
 - Detailed FEL study to saturation (VISA, LEUTL, SDL, TTF-FEL).
 - CSR (preliminary results reported, much more work is needed).
 - Rough surface impedance.
5. There is acute need to develop an ultra-stable drive laser for photoinjectors.
6. While the photoinjector, the linac and FEL theory seem to be mature fields, but:
 - New photoinjector ideas appear (the pulsed diode at GV/m gradient)
 - New phenomena are being discovered (CSR, rough surface impedance)
 - New possibilities exist (HGHG)

Looking towards the future, we see a definite progress towards linac based, high-gain, short-wavelength FEL in theory, simulations, conceptual design and proof-of-principle experiments. The near future will yield a wealth of experimental results in this field.

List of participants:

Masami Ando, KEK; Hartmut Backe Universitaet Mainz; Rene Bakker, BESSY; Karl Bane, SLAC; Sandra Gail Biedron, ANL; J. Bisognano, JLAB; Zhonghou Cai, ANL; Bruce Carlsten, LANL; Roger Carr, SLAC; William Colson, NPS; Max Cornacchia, SLAC; Pascal Elleaume, ESRF; Paul Emma, SLAC; William Fawley, LBNL; Massimo Farrario, INFN-LNF; Jean-Marc Filhol, ESRF; Henry P. Freund, SAIC; Wei Gai, ANL; John Goldstein, LANL; Ching-Hung Ho, SRRC; Zhirong Huang, ANL; Gerhard Ingold, Paul Sherrer Institut; Eberhard Jaeschke, BESSY; Shaikat Khan, BESSY; Jean-Louis Laclare, Projet SOLEIL; J. R. LeDuff, LAL; Marie-Paule Level, Projet SOLEIL; Alex Lumpkin, ANL; Kirk McDonald, Princeton University; Stephen Milton, ANL; Alban Mosnier, Projet SOLEIL; Ali Nassiri, ANL; Dinh Nguyen, LANL; Kazuhito Ohmi, KEK; Dennis T. Palmer, SLAC; Claudio Pellegrini, UCLA; Mike Poole, CLRC Daresbury Lab; David Quimby, STI Optronics, Inc.; George Rakowsky, BNL; Sven Reiche, DESY; Annick Ropert, ESRF; Shogo Sakanaka, KEK; Jochen Schneider, DESY; Stanley O. Schriber, LANL; Roman Tatchyn, SSRL; Gil Travish, ANL; M. J. Van Der Wiel, University of Technology; Ernst Weihreter, BESSY; Thomas Weis, Universitaet Dortmund; Marion White, ANL; Herman Winick, SLAC; Gode Wuestefeld BESSY; Ming Xie, LBNL; Tetsuo Yamazaki, Institute of Advanced Energy; Yan Yin, YY Labs, Inc.; Li Hua Yu, BNL;